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Muffins Incorporated with Multiple Blend Functional Ingredients: Development, Sensory Evaluation, Proximate Composition and Total Antioxidant Activity

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Abstract—*Three variations T_1, T_2, T_3 (T_1 control and T_2, T_3 experimental) of muffins were standardized using defatted soya flour: refined wheat flour and defatted soya flour: whole wheat flour as basic ingredients in 25: 75 in each variation, respectively. Further, wheat bran was added as 24 per cent of the total flour mixture in both experimental variations. Furthermore, functional ingredients viz. tangerine peel powder and tomato pulp were incorporated in the ratio of 1 and 8 in T_2 whereas in T_3, tangerine peel powder was superseded by ginger while the amount remained same. Other ingredients such as black pepper and turmeric were used in the ratio of 1 and 2. All the developed products were evaluated in terms of their sensory evaluation, proximate composition and total antioxidant activity. The findings revealed that there was a significant difference ($p<0.05$) in sensory and proximate parameter scores among all the variations. It was observed that T_3 had highest index of acceptability (87.78 per cent) followed by T_1 (82.44 per cent) and T_2 (68.44 per cent). Higher contents of protein and fiber as 16.2 per cent and 13.5 per cent were found in T_3 and T_2, respectively as compared to T_1. Simultaneously, a significant difference ($p<0.05$) was observed, in the level of total antioxidant activity, along with highest value, obtained by T_2.*

1. INTRODUCTION

Several new trends have been emerging to food industry in contemporary era, with major emphasis on functional food production, since a continuous increase was noted in the level of awareness among the consumers with regard to nutritional security during both normal health and disease conditions. Baked products such as breads, muffins and cakes have been most popular among all the age groups from childhood to adulthood the world over because of their special organoleptic characteristics [1]. Muffin is a type of baked bread, without icing and less sweet than a cupcake. It can be served both during breakfast and mid-evening meal [2]. Apart from their delicious taste, their functionality can be worked out for therapeutic consumption for the patients suffering from different diseases by changing the type of fat used and incorporating functional ingredients while preparing the batter for muffins and cakes.

Few efforts have been made by some scientists via incorporating various foods viz. bengal gram flour, carrot powder, date, soybean, wheat bran etc. to improve protein, vitamin and fiber contents of final products [3, 2, 4]. With changing food habits in both rural and urban setups, muffins are consumed among masses as being an concentrated source of energy. This food product is also suitable to enhance its nutritive potential in form of vitamins and minerals. Moreover, this approach may add variations to individuals' diet which is the most desirable facet of both normal and therapeutics nutrition. Taking all these evidence into consideration, muffins have been modified, through working out a mixture of functional ingredients, present in numerous locally available foods during present study.

2. MATERIAL AND METHODS

2.1 Procurement of raw material

Refined wheat flour (*maida*), whole wheat flour, wheat bran, powdered sugar, baking powder and ammonium bi-carbonate were procured from Raj *Karyana* Store, Ludhiana, India. Defatted soya flour (toasted, Taj Mahal Allegro brand) containing 0.5 per cent fat and 50 per cent protein) was bought from Super Foods, Chandigarh, India. Fresh ginger and tangerine peels were collected from local vegetable market, Phagwara, India and both the ingredients were finely grated and dried at 60°C to obtain moisture content up to 8 per cent and were ground to a fine powder. To produce a reform particle size, these were sieved through sieve-shaker (1mm)

and the resultant powders so obtained were stored in food grade, air-tight containers in a dry place prior to use. Perishable foods i.e. tomatoes and butter (Amul Delicious with 0 per cent trans fat and cholesterol) were purchased from WH Smith General Store, Lovely Professional University, Phagwara, India, at the time of preparation of muffins.

2.2 Development of muffins

Table 1: Raw ingredients used for muffins

S. No.	Ingredients	T1 (g)	T2 (g)	T3 (g)
1.	Refined flour	150	---	---
2.	Whole Wheat flour	---	150	150
3.	Defatted Soya flour	50	50	50
4.	Bran	---	48	48
5.	Sugar (Powdered)	65	65	65
6.	Butter	130	130	130
7.	Tomato pulp	---	96	96
8.	Ginger (Powder)	---	---	12
9.	Tangerine peel powder	---	12	---
10.	Black pepper	---	1	1
11.	Turmeric	---	2	2
12.	Baking powder	7.5	7.5	7.5

Where **T_1(Control)** = 25% Defatted Soya Flour, 75% Refined Wheat Flour,

T_2 (Experimental) = 25% Defatted Soya Flour, 75% Whole Wheat Flour, Tangerine peel powder: Wheat Bran: Tomato pulp = 1:4: 8 and Black pepper: Turmeric = 1: 2 and

T_3 (Experimental) = 25% Defatted Soya Flour, 75% Whole Wheat Flour, Ginger powder: Wheat Bran: Tomato pulp = 1: 4: 8 and Black pepper: Turmeric = 1: 2

2.3 Method for preparation

Butter was creamed along with consistent addition of sugar. All the raw ingredients were added and mixed to attain a uniform batter. After greasing the muffin moulds, the better was poured into the moulds and baked at the temperature of 170°C for 25 minutes.

2.4 Sensory evaluation

Three different variations of muffins (one control and two experimental) were evaluated through measuring their sensory attributes viz. appearance, color, texture and flavor (aroma/taste) along with overall acceptability score using 9 point Hedonic scale system [5] by a panel of 10 expert judges. Prior to commencement of the test, judges were explained about each sensory attribute to ensure correct interpretations. Significance of rinsing mouth after making each evaluation was also elucidated providing drinking water at room temperature. Each treatment was scored differently from 1 (dislike extremely) to 9 (like extremely) in order to measure the acceptability level of developed products. After collecting scores from all the panelists, each formulation of biscuits were expressed as Mean± SD score.

2.5 Proximate composition

The raw ingredients and muffin samples were analyzed nutritionally by determining the moisture, protein, fat, fiber, ash and carbohydrate contents in triplicates [6].

2.6 Total antioxidant activity

All the raw ingredients and developed products were assessed to check out their total antioxidant activity [7].

2.7 Statistical analysis

The obtained data was analyzed statistically through working out One-way analysis of variance (ANOVA) with Tukey's test using GraphPad Prism software version 5.01 [8] in order to determine the significant difference ($p<0.05$) between variations of muffins.

3. RESULTS AND DISCUSSION

3.1 Sensory evaluation of muffins

The scores obtained under various sensory parameters of muffins were shown in Table 2. Results have revealed that there is a significant difference ($p<0.05$) in appearance, color, texture and flavor between both control and experimental variations. The highest (8.1) mean score for appearance was observed in T_3 followed by T_1 (7.4) and T_2 (6.3), respectively. Soya flour and other ingredients such as basil leaves in the batter prepared for the muffin development were responsible for making the final product of darker color due to Millard reaction in presence of reducing sugars, amino acids, moisture content of the dough and time and temperature of baking [9-11]. At the same time, increased soyabean supplementation to wheat flour resulted in enhance browning in muffins, was attributed to higher content of amino acids [12]. Similar observations were recorded in the present study.

As far as the texture was concerned, a significant difference ($p<0.05$) was observed among all the three variations. It was seen that T_3 was again found as superior among all the variations. In another study, it has been reported that the variations with 10 per cent and 30 per cent substitution of wheat flour with soy flour were found to be more acceptable with average scores of texture as 5.2 and 5.4 on comparison to 20 per cent and 40 per cent substitutions having 4.9 and 5.0, respectively [13]. Moreover, the values for flavor of the muffins were as high as 8.0 and 7.5 in T_3 and T_1, respectively. It was evidently reported that incorporation of defatted soy flour into wheat flour was associated with roasted flavor or aroma [14]. Both T_3 and T_1 obtained highest overall acceptability scores as 8.0 and 7.5, respectively, whereas T_2 scored least (6.1) for the same. Higher acceptability scores can be achieved by incorporating soya flour at 10 and 20 per cent levels [15].

Furthermore, the mean score for color of the muffins was ranged from 6.2 to 7.7. The lowest score was recorded in T_2 while the highest value was observed in T_3. Simultaneously, T_1 was at second position with the mean score of 7.4. Various investigations have concluded that addition of soya bean flour supplementation was acceptable only up to 30 per cent level during preparation of batter for muffins.

Table 2: Sensory attribute scores of Muffins

Parameters	T1	T2	T3
Appearance	7.4±0.52a	6.3±0.67b	8.1±0.74ac
Colour	7.4±0.52a	6.2±0.63b	7.7±0.67ac
Texture	7.3±0.42a	6.0±0.16b	7.7±0.48ac
Flavour (Aroma/Taste)	7.5±0.74a	6.2±0.63b	8..0±0.62ac
O. A.	7.5±0.58a	6.1±0.52b	8.0±0.47ac
I. A. (%)	82.44	68.44	87.78

Where **T_1(Control)** = 25% Defatted Soya Flour, 75% Refined Wheat Flour

T_2 (Experimental) = 25% Defatted Soya Flour, 75% Whole Wheat Flour, Tangerine peel powder: Wheat Bran: Tomato pulp = 1:4: 8 and Black pepper: Turmeric = 1: 2

T_3 (Experimental) = 25% Defatted Soya Flour, 75% Whole Wheat Flour, Ginger powder: Wheat Bran: Tomato pulp = 1:4: 8 and Black pepper: Turmeric = 1: 2

3.2 Proximate composition of raw ingredients

Table 3 depicts the proximate composition of raw ingredients. The moisture contents of key flours viz. defatted soya flour, refined wheat flour and whole wheat flour were ranged from 7.79 to 11.4 per cent. Among all, defatted soya flour had utmost protein content (59.21 per cent), may be, due to, its high water holding capacity and low moisture content [16,17]. Little amount of fat has been detected, in defatted soya flour (0.75 per cent), refined wheat flour (0.85 per cent) and tomato (0.28 per cent). At the same time, tangerine peel powder was analyzed, with relatively higher (11.14 per cent) amounts of fiber, having fair amounts of pectin [18, 19]. These findings were in agreement with USDA National nutrient database (10.68 per cent) [20]. Notable amounts of minerals, in the form of ash content were observed in defatted soya flour (7.38 per cent), and might be attributed to higher amount of total dry solids as well as emulsifying properties when compared with other ingredients [21], followed by ginger (4.75 per cent), and tangerine peel powder (4.48 per cent), particularly, due to presence of good amounts of potassium in it [22]. Furthermore, the computed values for carbohydrate were reported as 20.73, 71.02, 77.59, 57.62, 2.86, 28.06 and 11.3 per cent in defatted soya flour, refined wheat flour, whole wheat flour, wheat bran, tomato, tangerine peel powder and ginger, respectively. The observed values for above-mentioned nutrients were close to the reference values [22].

Table 3: Proximate composition of raw ingredients

Sample	Moisture (%)	Protein (%)	Fat (%)	Fiber (%)	Ash (%)	CHO (%)
R1	7.79 ± 0.41a	59.21 ± 0.91a	0.75 ± 0.11a	4.28 ± 0.18a	7.38 ± 0.39a	20.73 ± 0.41a
R2	11.4 ± 0.36b	9.26 ± 0.28b	1.15 ± 0.13ab	0.00 ± 0.00b	0.60 ± 0.06b	77.59 ± 0.59b
R3	11.2 ± 0.30bc	11.25 ± 0.48c	0.85 ± 0.12ab	1.47 ± 0.27c	2.26 ± 0.18c	73.02 ± 0.77c
R4	7.2 ± 0.35ac	25.59 ± 0.88d	4.62 ± 0.27bc	1.97 ± 0.21c	2.12 ± 0.12cd	57.62 ± 0.44d
R5	93.96 ± 0.26bd	1.57 ± 0.35e	0.28 ± 0.04ad	0.85 ± 0.11d	0.47 ± 0.16bd	2.86 ± 0.34e
R6	8.2 ± 0.36ad	5.3 ± 0.11f	2.2 ± 0.30be	11.14± 0.22e	4.48 ± 0.23c	68.68 ± 0.42f
R7	7.9 ± 0.35ad	12.4 ± 0.25c	7.73 ± 0.25cf	10.47± 0.28f	3.75 ± 0.14d	57.7 ± 1.04d

*Values are mean ± SD from triplicate determinations; different superscripts in the same row are significantly different ($p<0.05$)

Where **R1**= Defatted Soya Flour, **R2**= Refined Wheat flour, **R3**= Whole Wheat Flour, **R4**= Wheat Bran, **R5**= Tomato, **R6**= Tangerine peel Powder, **R7**= Ginger

Where **T_1(Control)** = 25% Defatted Soya Flour, 75% Refined Wheat Flour

3.3 Proximate composition of muffins

The Proximate composition of muffins has been presented in Table 4. The results showed that there was a significant difference ($p<0.05$) between the moisture content in all the three variations of muffins. The moisture content of different variations was ranged between 26.42 and 33.46 per cent and it was also seen that T_2 was less (26.42 per cent) moistened as compared to T_3 (33.46 per cent) and T_1 (27.64 per cent), respectively. The moisture content was observed as 33, 36 and 37.50 per cent in 10, 20 and 30 per cent defatted soya flour supplementation in whole wheat flour bread during another study [13]. The highest protein content was found in T_3 as 16.2 per cent and the lowest was observed as 14.0 per cent in T_1 since possessing the same amount of soya flour but it was due to the substitution of refined wheat flour with wheat flour and addition of wheat bran, tomato, ginger in the flour mixture for T_2 and T_3. It was observed during an investigation that the protein content (11.23 per cent) was lesser and carbohydrate content was higher (47.13 per cent) in control sample whereas on enrichment with 20 per cent soybean and cassava flours,

protein had increased to 13.08 per cent with decreased carbohydrate content (23.11 per cent) [15]. The fat content ranged from 20.75 to 23.55 per cent. Although, same amount of shortening was incorporated in all the variations. This could be due to different levels of fat contained by various raw ingredients.

The maximum fiber content was observed in T_2 as 13.5 per cent followed by T_3 as 9.5 per cent. The increase in fiber content could be due to value addition of wheat bran, tomato pulp, citrus peel powder and ginger powder. Increased protein and fiber contents might be associated with fermentation process which takes place during batter preparation and increased amount of moisture [23, 24]. Similar trend was observed in T_2 and T_3 variations when the fiber was incorporated in experimental samples in the form of wheat bran. The ash content of products ranged from 1.70 to 2.28 per cent. The highest value was obtained by T_2 whereas the lowest value was scored by T_1. Further, the carbohydrate content ranged from 16.86 to 31.86 per cent which was found to be almost halved in experimental variations due to presence of complex carbohydrates in the form of fiber in higher amounts as compared to the control.

Table 4. Proximate composition of muffins

Parameters	T1	T2	T3
Moisture (%)	27.64±0.13a	26.42±0.11ab	33.46±0.16ab
Protein (%)	14.0±0.23a	15.75±0.36b	16.2±0.24c
Fat (%)	20.75±0.23a	23.55±0.36b	21.70±0.24c
Fiber (%)	4.9±0.08a	13.5±0.11b	9.5±0.13c
Ash (%)	1.70±0.21a	2.27±0.16ab	2.18±0.18bc
Carbohydrate (%)	31.01±0.49a	18.6±0.11b	16.87±0.37bc

Where **T_1(Control)** = 25% Defatted Soya Flour, 75% Refined Wheat Flour

T_2 (Experimental) = 25% Defatted Soya Flour, 75% Whole Wheat Flour, Tangerine peel powder: Wheat Bran: Tomato pulp = 1:4: 8 and Black pepper: Turmeric = 1: 2

T_3 (Experimental) = 25% Defatted Soya Flour, 75% Whole Wheat Flour, Ginger powder: Wheat Bran: Tomato pulp = 1:4: 8 and Black pepper: Turmeric = 1: 2

3.4 Total antioxidant activity of raw ingredients

It has been observed in Figure 1 that tomato and tangerine peels have a great potential to quench free radicals.

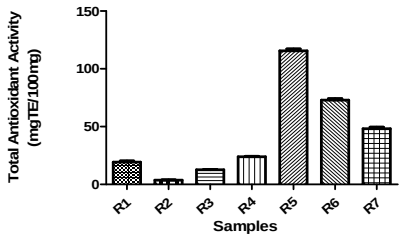

Figure 1. Antioxidant activity of raw ingredients

3.5 Total antioxidant activity of developed products

A significant ($p<0.05$) difference was observed in total antioxidant activity of control and experimental samples (Figure 2). Legume flours, be full of antioxidants, are responsible, to increase free radical scavenging activity of the final product, when added to wheat flour [25]. Thus, T_2 followed by T_3 possess higher values of free radical scavenging activity, may be attributed to combined effect of, incorporation of tomato, tangerine peel and ginger; and maillard reaction which took place during baking [26, 27]. A significant increase ($p<0.05$) in antioxidant activity (ranged from 1.17 to 2.19 mmol/TEAC/g), on elevated level (from 5 to 20 per cent) of orange peel supplementation to pearl millet was recorded, during formulation of products from pearl millet [19].

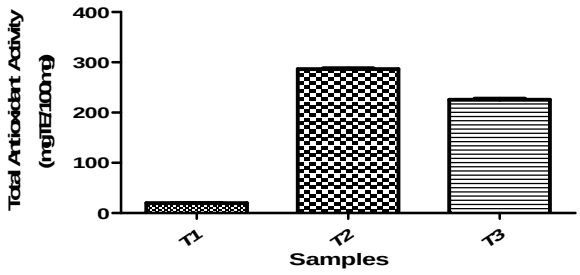

Figure 2. Total Antioxidant activity of muffins

4. CONCLUSION

It is to conclude that samples containing whole wheat flour, tomato pulp and ginger i. e. T_3 have been found to be highly acceptable among all the variations. Moreover, the nutritional and antioxidant potential were also higher in this variation. Therefore, T_3 can be recommended as the most suitable formulation of muffins.

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